

NOTES:

- (1) As there is no means of detecting whether paper has been inserted, please ensure that the paper is correctly positioned **BEFORE** switching on in this mode. The pens will start to write soon after the power is switched on in this mode and will deposit ink on the platen. This will discolour the reverse of paper subsequently inserted into the plotter.
- (2) The test uses all four pens, so they should all be inserted if a full test pattern is to be drawn.

See color samples at the beginning of this manual for test patterns.

When an error is detected in the control circuit check, the ERROR LED will flash. No test pattern will be drawn.

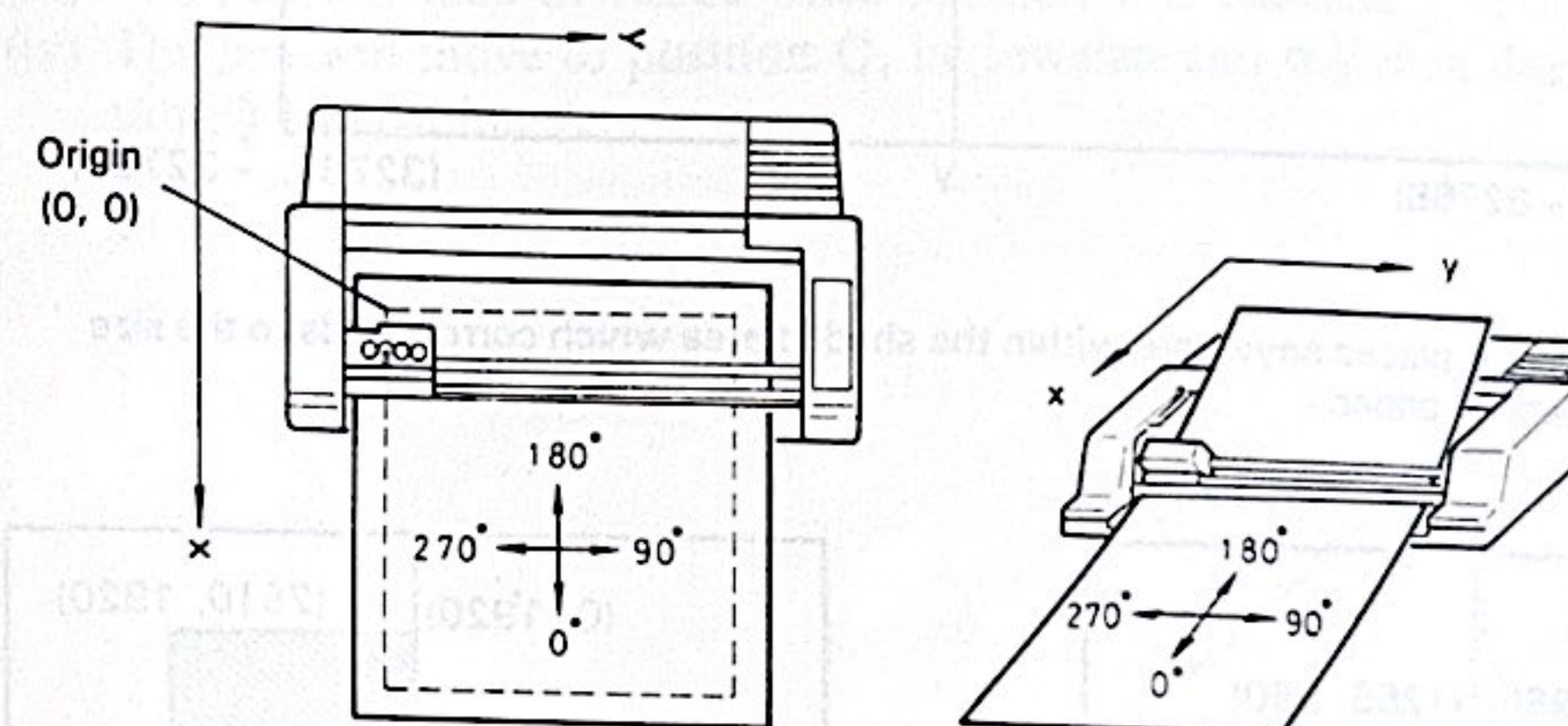
When a test diagram has been drawn, the plotter is placed in the change paper position, although the ON LINE LED will not be flashing as in a normal change paper state. If one of the POSITION switches is pressed a further pattern will be drawn.

To use the HI-80 normally in either plotter or printer mode, it must be switched off and on again.

3.2 Coordinates and General Plotter Commands

In using the plotter it is necessary to position the pen at a known place on the paper. The convention used for this is the standard Cartesian coordinate system. In this system the position of a point is given as two numbers. The first number of the pair denotes the position along the X axis, and the second in the Y axis. The convention for the HI-80 is that the Y axis is in the direction of the pen movement and the X axis at right angles to this, in the direction of the paper movement. In printer mode it is possible to set the direction of printing to be along either axis temporarily with a software command.

The ranges of the coordinates on the X and Y axes are shown in table 3-1. They depend on the size of paper used. When the printer is switched on or the default value is set the origin is at the bottom left of the paper if it is held with the X axis horizontal and the Y axis vertical.

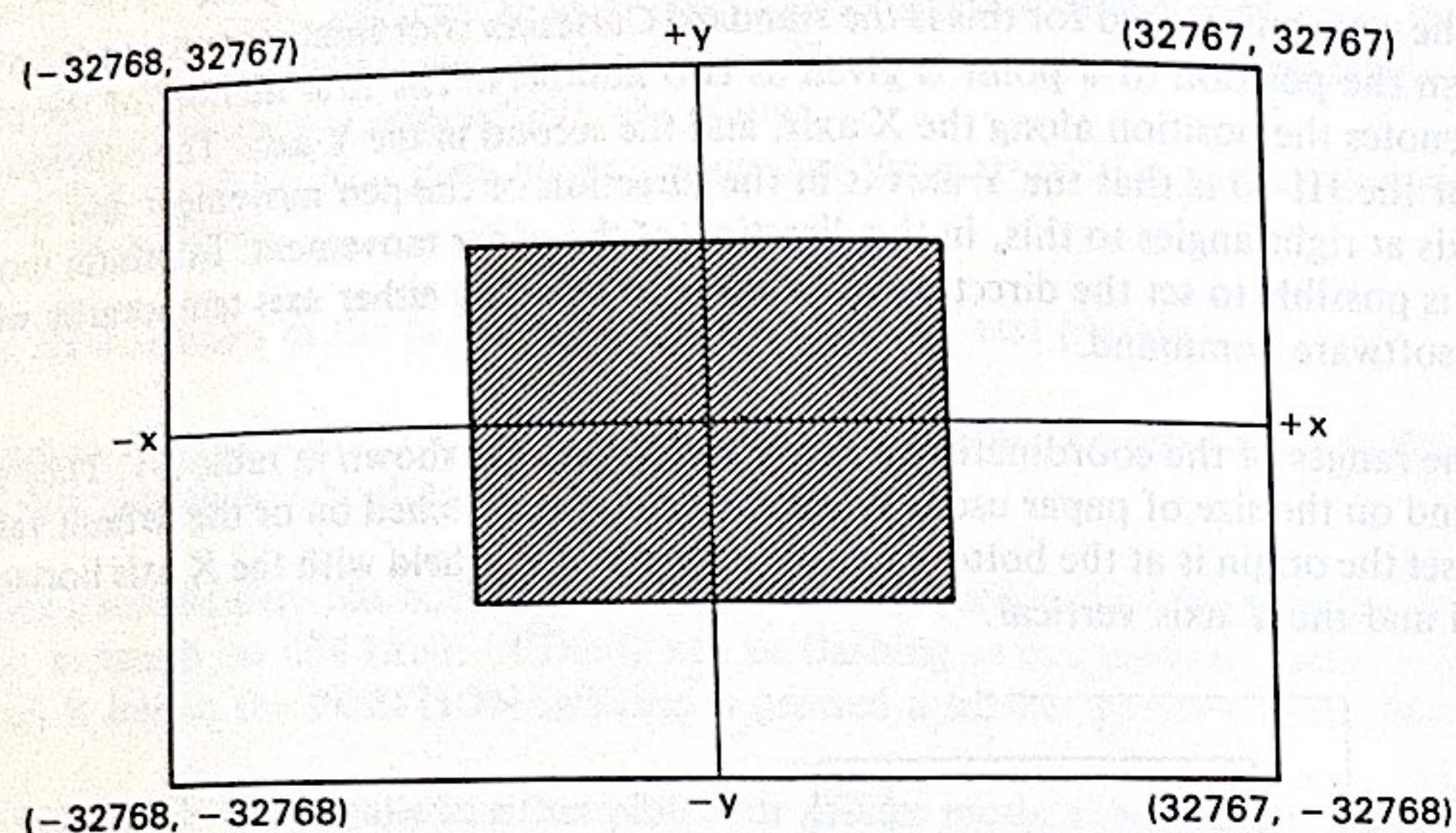


The values of the coordinates of the plotting area are shown in the following table, for different paper sizes. The plotting area is within a border whose position on the paper is shown in section 2.6.1.

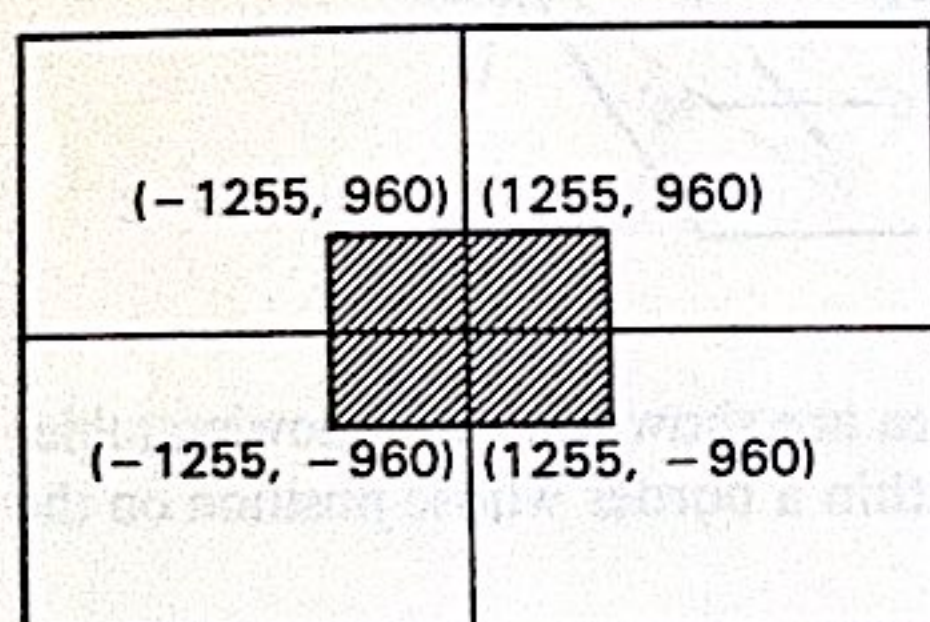
Table 3-1

Paper Size	Effective drawing size	Range for X	Range for Y
A4	267 × 192 mm	0 - 2670	0 - 1920
US letter	249 × 192 mm	0 - 2510	0 - 1920
B5	227 × 164 mm	0 - 2270	0 - 1640

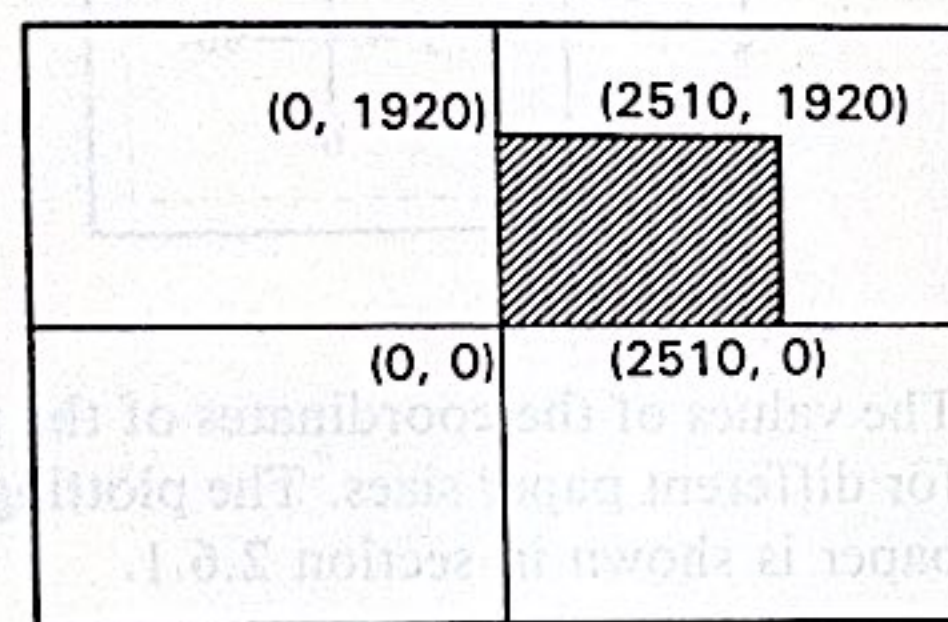
The origin can be positioned anywhere inside the plotting area. The effective plotting area is shown in the following two examples:



The origin can be placed anywhere within the shaded area which corresponds to the size of four sheets of paper.



<Origin in center of paper>



<Origin at corner of paper>

Paper position showing effective drawing area on virtual drawing board for US letter size paper.

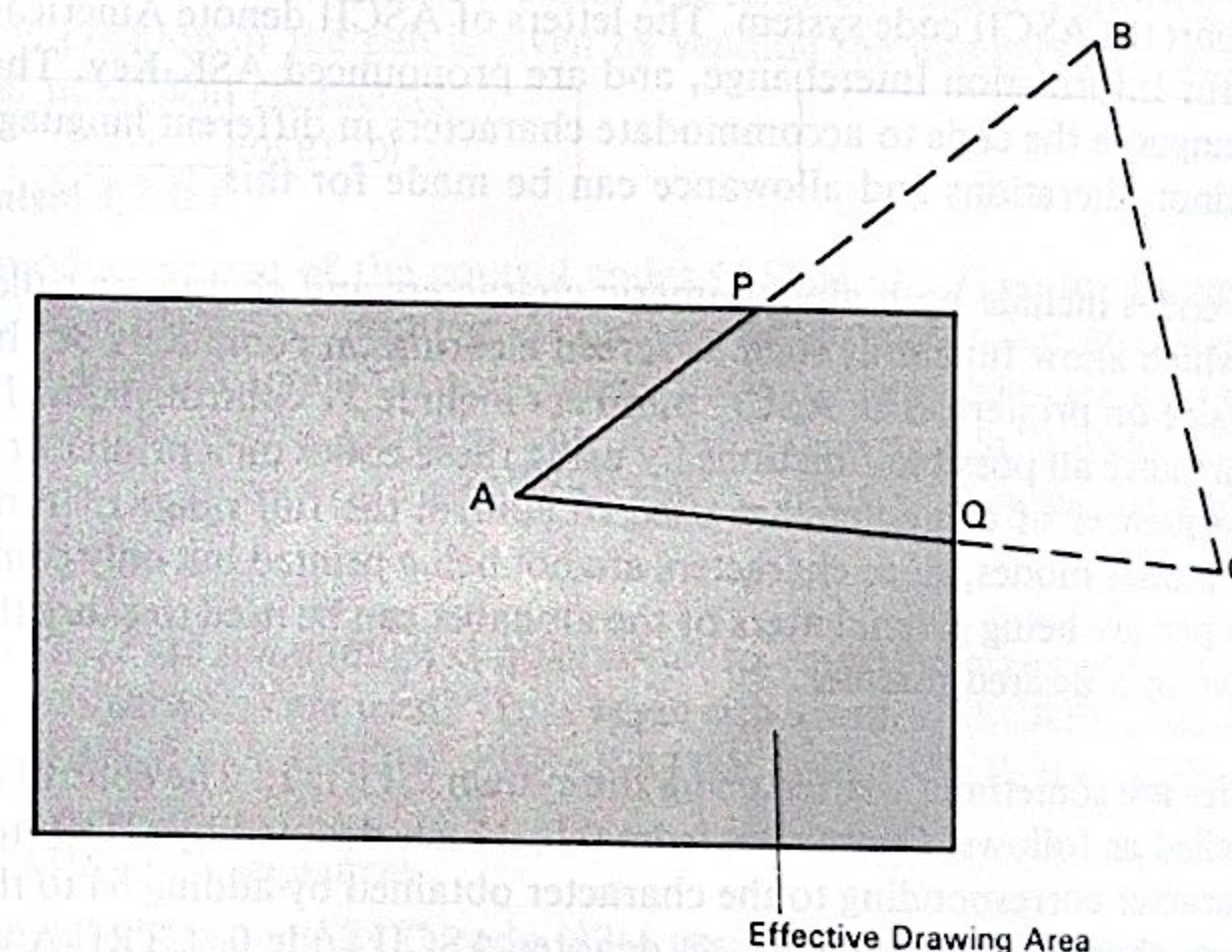
Paper Size	Effective Drawing Area	Range for X	Range for Y
A4	105 mm x 148 mm	0 - 32767	0 - 32767
US letter	102 mm x 142 mm	0 - 32767	0 - 32767
B3	164 mm x 229 mm	0 - 32767	0 - 32767

3.3 Clipping

The plotting area is a window on a much larger area and the origin for plotting can be moved anywhere on the paper by a simple software command. If values for point coordinates are outside the designated plotting area, no error will be generated provided they are within the range -32768 to 32767. When a command is given which involves plotting from a point outside the designated area to one inside it, or vice versa, plotting will occur up to the edge of the window. This is known as clipping. Following figure shows an example of the effect of drawing a triangle specified as points A,B,C in order of drawing from point A to B to C and back to A again.

When the triangle is drawn the following sequence of operations will take place:

- The pen will move to the position of point A in the raised position.
- The pen will be lowered and draw from point A to point P.
- The pen will then be raised when position P is reached.
- The pen will move to position Q, be lowered and will then draw from position Q to position A.



3.4 Using the Software Commands

3.4.1 Number bases and notation

In describing numbers, it will be necessary to use the decimal (base 10), binary (base 2) or hexadecimal (base 16) notation. The number 65 in decimal notation would be printed as follows where it is necessary to be clear about which number base is intended.

(65) _D	denotes Decimal
(01000001) ₂	denotes Binary
<41> _H	denotes Hexadecimal

In MICROSOFT BASIC the symbol pair &H denotes the number following is in hexadecimal format. Thus CHR\$(65) is an example of a command using decimal notation and CHR\$(&H41) denotes the same command using hexadecimal notation.

3.4.2 ASCII codes

A computer and its ancillary equipment (printers, plotters etc) are digital devices. They function by manipulating numbers. When the computer and the peripheral devices communicate they do so in numerical form, using a numerical code to represent the characters sent. In order to ensure that the two devices interpret the characters in the same way, a standard code has to be agreed. Most computers and peripheral devices support the ASCII code system. The letters of ASCII denote American Standard Code for Information Interchange, and are pronounced ASK-Key. There can be slight changes in the code to accommodate characters in different languages, but these are minor alterations and allowance can be made for this.

The ASCII codes include both alphanumeric characters and characters called control codes which allow functions such as screen clearing on computers or changing of the type size on printers. The ASCII numbers include 31 control codes. It is not possible to achieve all possible functions by using these codes on a printer or plotter so certain sequences of characters are used to control the full range of functions. Also, in the plotter modes, since characters are not being printed but only commands to move the pen are being given, letters of the alphabet can be used to cause the plotter to behave in a desired manner.

Control codes are sometimes written using the system CTRL-L. The control characters are labelled as follows. Characters from 0 to 31 are denoted by CTRL together with the character corresponding to the character obtained by adding 64 to the code of the control character. Thus CTRL-@ denotes ASCII code 0, CTRL-A denotes ASCII code 1, CTRL-L denotes ASCII code 12 and so on. Many computers have a key marked CTRL which will yield CTRL-A for example when pressed at the same time as the A key. Some manuals and computers use the symbols “^A” to denote CTRL-A.

3.4.3 Character sets and print styles

The HI-80 supports the following types of character sets

- Predefined character sets - held in ROM
These include variations for different countries.
- User defined character sets.
In order to obtain these optional RAM must be added.

The character sets (the actual characters printed) should not be confused with the styles of character. The standard HI-80 supports a number of print styles (including italic printing and two different fonts, Pica and Elite).

3.4.4 Software command sequences for controlling the plotter and printer

The HI-80 has the ability to function both as a plotter (in two modes) and a printer and so has a three sets of control sequences, one for each of the plotter modes and one for the printer mode. The commands fall into the following categories:

a) Alphanumeric Sequences

In the two plotter modes, the commands to control the pen are given as pairs of letters (mode 0) or single letters (mode 1). This is because the characters can only be interpreted as control characters unless a specific command is given to plot characters. The position of the pen is given by sending the numbers as a sequence of individual numerical characters.

b) Control Codes

Some modes use one of the control codes (ASCII (0 - 31)_D) to change to another mode or alter the style of printing. As they are non printable characters they are mainly used in the printer mode. In some cases these control codes are used as part of a sequence of characters. Certain control codes such as ASCII code (13)_D <0D>_H (the carriage return code) are used by all modes, although they may be used in a different manner.

Because there are not enough control codes to cover the many possible options, sequences of characters are used. These begin either with a ESCAPE code (ASCII code (27)_D, <1B>_H) or a GROUP SEPARATOR code (ASCII code (29)_D, <1D>_H).

c) ESCAPE code sequences

The control character ASCII code (27)_D is used in the printer mode to signal that a sequence of characters are to be sent to change one of the printer mode parameters, for example to set underlining or line spacing. In all further references to the ESCAPE character where it is not mentioned as an ASCII code, the symbol <ESC> will be used.

Unlike control codes, <ESC> code sequences vary from printer manufacturer to printer manufacturer, but those for the HI-80 are compatible with those of other EPSON printers.

Note:

Some computers have a key marked ESCAPE. This will often generate the character with ASCII code (27)_D, but in many cases it performs a role such as allowing an exit from a program. The ESC code means ASCII code (27)_D and nothing more.

d) Group Separator sequences.

A further set of sequences are used to control the graphics parameters in the printer mode. Two examples of its use are to change the pen and set the character height.

These sequences employ the Group Separator character, ASCII code (29)_D. In all further references to the Group Separator character where it is not mentioned as an ASCII code, the symbol <GS> will be used.

3.4.5 The meaning of a form

When using a standard computer printer (dot matrix or daisy wheel), it is possible to use fanfold paper. The form length then means the distance between the perforations. In this case the printing the form feed character will move the print head to the top of the next form. The form length can be set using either a command to the printer, or by an applications software program counting the number of lines of text sent to the printer. With the HI-80, because the paper moves in both directions, it is not practical to use fanfold paper in the plotter modes. However, in printer mode this may still be practical. For details of the form length in printer mode see section 6.6. In plotter or printer mode a form means a separate piece of paper.

3.4.6 Software control of the HI-80

The HI-80 is controlled by sending it a sequence of characters. The characters required are different for the plotter and printer mode. The following summary shows how to send characters to the printer.

a) Using BASIC with the HI-80

In order to explain the use of the printer this manual uses the BASIC programming language for examples. Other languages and the use of applications programs are discussed in section 7.2.

Because there are many dialects of BASIC, a standard form of MICROSOFT BASIC has been used for the examples. The command to send a character to the printer in MICROSOFT BASIC is LPRINT. Some computers require a file to be opened to the printer port and then use the command PRINT # followed by the number of the file opened. Yet another type of computer uses a command to switch all output to the printer and then the straight PRINT command. If your computer has a dialect of MICROSOFT BASIC which does not correspond with the standard one using LPRINT to communicate with the printer, consult your computer manual to determine how to send characters to the printer port.

Some interfaces and BASIC dialects use certain control characters (in particular ASCII code (9)_D and ASCII code (4)_D) for their own purposes. In these cases it may be necessary to resort to other means to send these characters. Some hints are given in section 4.7.

b) Plotter modes 0 and 1

In these modes the characters used to control the printer consist of a pair of alphabetic characters (mode 0) or a single character (mode 1). These are followed in most cases by numerical parameters, separated by a delimiter which may be a space or a comma depending on the command. The command is then terminated by either a carriage return or the character ASCII code (0).

Examples of commands are:

OR

This command sets the origin to the current pen position in mode 0. It does not have any parameters. It would be sent to the printer with the command:

LPRINT "OR"

The command in mode 0 to draw from the current pen position to the point with coordinates 200,160 then to the point with coordinates 300,1280 is:

DA 200,160,300,1280

It would be sent to the printer with the BASIC command:

LPRINT "DA 200,160,300,1280"

The equivalent command in mode 1 is:

D 200,160,300,1280

and would be sent to the printer with:

LPRINT "D 200,160,300,1280"

If the numerical data is either a constant or a numerical variable, the following formats are also possible:

LPRINT "DA" ; 200 ; "," ; 160

LPRINT "DA" ; X ; "," ; Y

where X and Y are variables containing the values of the coordinates of the point to be drawn to.

- The following points should be noted when sending the numerical parameters:

Numerical parameters must be integers.

Any numbers after a decimal point will be ignored.

Leading zeros are ignored.

Signs can be specified with + or -.

If no signs are included + will be assumed.

Coordinates and lengths are specified in multiples of 0.1 mm.

Angles are specified in multiples of 0.1 of a degree.

The range of the numeric parameters varies with the command, details being given under each command. If a numerical parameter is zero it may be omitted, but the delimiter must be inserted before the next parameter. For example:

DA ,200 may be used for DA 0,200

If an excessive number of parameters are given, the excess will be ignored, without generating an error. Spaces either side of numerical parameters will be ignored. For example:

DA 100 , 100 is as valid as DA100,100

- The following points should be noted when sending command characters:

The command characters may be in upper case (capital letters) or lower case or a mixture of the two.

If the command is omitted and the numbers parameters alone are sent an error will be generated.

- Some commands require ASCII code parameters. For example to switch to printer mode from plotter mode 0 the ASCII character (18)_D must be used. This would be sent to the printer using:

LPRINT CHR\$(18)

- The command must be terminated with either a carriage return ASCII code (13)_D, <0D>_H or ASCII code (0) which is CTRL-@. The BASIC command LPRINT adds a carriage return automatically unless a semi-colon follows the data to be printed. In the unlikely event that a semi-colon is required the character whose ASCII code is 0 must be added to the data. For example:

LPRINT "DA 200, 300"; CHR\$(0);

could be substituted for

LPRINT "DA "200, 300"

In the software command format the ∇ character signifies a terminator.

c) Printer mode

There are three types of commands which can be used with the printer mode.

- Some control codes will cause changes in the size of the printed characters. For example if the ASCII code (15)_D is sent the characters will be reduced in size. Other control codes perform functions such as backspacing and tabulation. To change the size of the characters the BASIC command would be:

LPRINT CHR\$(15);

- The main command is an <ESC> sequence. The <ESC> sequences are of two types. The first type involves the <ESC> character followed by an alphanumeric character or punctuation mark. The second type is an <ESC> character followed by an alphanumeric character followed by a number. This number is sent in the form of a ASCII code. For example <ESC> followed by the letter "A" and the ASCII code (n) sets the line spacing to n/72 of an inch. To alter the line spacing to 66/72 of an inch the sequence <ESC> A and ASCII code (66)_D would be sent. This is equivalent to <ESC> A B, since the ASCII code for the letter B is 66. Wherever a third character is required in the sequence it is number corresponding to the ASCII code which is the command character and not numerical character or sequence of characters. The BASIC command to set the line spacing to 66/72 of an inch could be one of the following:

LPRINT CHR\$(27) ; "A" ; CHR\$(66);

LPRINT CHR\$(27) ; CHR\$(65) ; CHR\$(66);

LPRINT CHR\$(27) ; "AB";

- The commands involved with graphics such as changing the pen, shifting to the plotter mode etc., involve <GS> sequences. Where three or more characters are present in the sequence, the third and subsequent characters are the numbers corresponding to the ASCII code. This is the same as in the <ESC> sequence mentioned above. For example to change from printer to plotter mode, the sequence is <GS> G, and in BASIC this would have the command format:

LPRINT CHR\$(29); "G"

d) Using the HI-80 with applications software

It is possible to combine printing of a word processor file with data presented in a graphics form. Details are given in section 7.2. There are also specific applications packages which support plotters. Some of these may be written for mode 1 commands specifying another plotter. If this is so, the HI-80 should be set to mode 1 in one of the following ways:

- The DIP SW-5 can be set so that the plotter is set to mode 1 as default on switching on the power.
- The mode can be switched to mode 1 using a software command.

The second method may be over-ridden if the software (for example booting a protected disk) causes the printer to be initialized, resetting it back to mode 0. In this case it may only be possible to run the software if the DIP switch is set in the correct position.

3.5 Formats

The following format is used to describe the commands in the different plotter and printer modes.

• In the plotter modes:

Name	Gives the name of the command.
Format	Gives a string which denotes the letter(s) of the command followed by the parameters required if any. The command has been written in upper case characters, but upper or lower case or a mixture of the two can be used. The delimiter “,” is also separated from the parameters by a space in most cases. This is simply to make the command easier to read. A space will be ignored if inserted. After the command string the ▽ character denotes the terminator which can be either a carriage return (ASCII code (13) _D) or a NUL character (ASCII code (0) _D). All parameters have been inserted inside the quotes because each character of a parameter which is numerical is sent to the HI-80.
Note:	<i>In general all parameters MUST be used with the command otherwise a Parameter Insufficient error will be generated. A few commands do not require all the parameters. This is described in the parameter range area of the description.</i>
Function	Describes the use of the command.
Parameter type and range	Describes type of parameter (a character or a number) and the range the parameter can take. It also describes any further points relating to the use of the command.
Example	Gives examples of the use of the command where such an example might clarify the use of the command. However, most commands are not used in isolation and chapter 7 gives an overall view of the use of the commands in programs.

ASCII code sequence

This gives the ASCII codes for the commands and the parameters both in decimal and hexadecimal numeration. The commands show both the terminators. However, they do not show the codes for the commands in upper and lower case. This section has been inserted to help those users who are working in machine code or whose application program or version of BASIC requires the ASCII code number to be inserted in controlling the printer. They have also been inserted to stress the difference between the plotter and printer modes commands in communicating numerical parameters. Plotter modes always send the parameters as strings of characters.

• In the printer mode.

The general format is essentially the same except that there is no Parameter Type and Range.

Name

Gives the name of the command.

Format

Gives the command using the BASIC command CHR\$() for the control code. Where a particular character follows the control code, the character is contained in quotes to denote the character to be sent. There is no terminator with a printer command. If a printer command is terminated with a carriage return, that carriage return will be effective in contrast to the plotter mode. Consequently all commands have been terminated with a semicolon.

Function

Describes the use of the command. It is followed by the description of the use of the command and how to set the parameters where necessary.

ASCII code sequence

This shows the sequence of characters to be sent to the printer in the same way as with the plotter mode. Its presence will be of more use to you than in plotter mode if the applications program you are using requires the ASCII codes in order to configure the printer.

Chapter 4 PLOTTER MODE 0 COMMANDS

4.1 Configuration Commands

IN

(Initialization)

Name	Initialization								
Format	"IN" ▽								
Function	Printing this string causes the plotter to be returned to the state at the time the power was switched on. This includes clearing the buffer. If the DIP switch has been set to place the HI-80 in plotter mode 1, this command will return it to that state. (See section 2.4)								
Parameter range	no parameters required								
Example	LPRINT "IN"								
ASCII Code Sequence	<table><tr><td>Decimal</td><td>(73)_D (78)_D (13)_D</td></tr><tr><td></td><td>or (73)_D (78)_D (0)_D</td></tr><tr><td>Hexadecimal</td><td><49>_H <4E>_H <0D>_H</td></tr><tr><td></td><td>or <49>_H <4E>_H <0>_H</td></tr></table>	Decimal	(73) _D (78) _D (13) _D		or (73) _D (78) _D (0) _D	Hexadecimal	<49> _H <4E> _H <0D> _H		or <49> _H <4E> _H <0> _H
Decimal	(73) _D (78) _D (13) _D								
	or (73) _D (78) _D (0) _D								
Hexadecimal	<49> _H <4E> _H <0D> _H								
	or <49> _H <4E> _H <0> _H								

DF

(Default)

Name Default value

Format "DF" ▾

Function Printing this string causes the plotter to be returned to the default state for this mode. The buffer will be cleared. Even if the DIP switch has been set to place the HI-80 in plotter mode 1 on power up, it will stay in mode 0.

The origin will be set to the corner of the paper just as if the HI-80 had been switched on.

A table of default values is given in section Appendix D.1.

Example LPRINT "DF"

ASCII Code Sequence

Decimal (68)_D (70)_D (13)_D

or (68)_D (70)_D (0)_D

Hexadecimal <44>_H <46>_H <0D>_H

or <44>_H <46>_H <0>_H

CI

(Clear Interface)

Name Clear Interface

Format "CI" ▾

Function To clear the input buffer and release the error state.

Parameters such as magnification and origin are not reset.

Example LPRINT "CI"

ASCII Code Sequence

Decimal (67)_D (73)_D (13)_D

or (67)_D (73)_D (0)_D

Hexadecimal <43>_H <49>_H <0D>_H

or <43>_H <49>_H <0>_H

CH

(Change paper)

Name Change paper position

Format "CH" ▾

Function To set the HI-80 in a position to allow the paper to be changed.

When the "CH" command is executed, the pen carriage moves to the right and the pens are capped. The paper moves up so that it can be released and removed. If the pen is set in the middle of the paper, it will be ejected from the machine. The ON-LINE LED will then start to flash indicating that the paper needs to be changed. When the paper has been replaced, the ON-LINE button should be pressed. The pen will move around the edge of the effective drawing area. This enables the window size to be seen in case it has been set to a size which is no longer required. Finally pen 1 is selected and placed on the X coordinate position setting before the command was executed.

Other than the pen number being changed, no other drawing parameters are altered.

Example LPRINT "CH"

ASCII Code Sequence

Decimal	(67) _D (72) _D (13) _D
or	(67) _D (72) _D (0) _D
Hexadecimal	<43> _H <48> _H <0D> _H
or	<43> _H <48> _H <0> _H

SP

(Select Pen)

Name Select Pen

Format "SPn" ▾

Function Selects a pen, or caps the four pens.

Parameter type and range

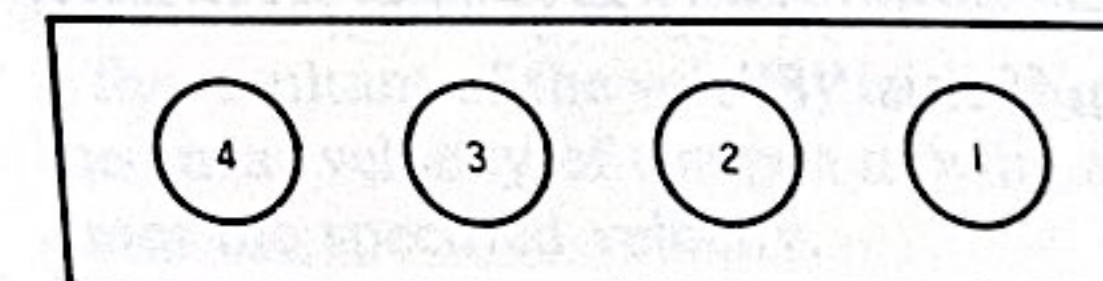
"n" is a character on the range -1~8.

Example

LPRINT "SP2"

This selects pen number 2.

The pen positions are marked on the pen holder and are as follows:



Pen number 1 is selected when the power supply is turned on. When an "SPn" command is executed, the pen is lifted, the pen carriage is moved to one end of the carriage and the pen is changed. If the pen number chosen is greater than the current one, the carriage moves to the right, if it is smaller it moves to the left. If the number is the same as the current pen number, no action is taken.

The pen is then returned to the coordinate position it was at when the "SPn" command was given.

When $n = 0$ or $n = -1$, the carriage moves to the right and the pens are stored and capped.

$n = 1$ or $n = 5$	pen 1 is selected
$n = 2$ or $n = 6$	pen 2 is selected
$n = 3$ or $n = 7$	pen 3 is selected
$n = 4$ or $n = 8$	pen 4 is selected

if $n > 8$ or $n < -1$, an error is generated.

The "SP0" command is equivalent to pressing the CAP/OFF key. The CAP/OFF key cannot be pressed if the ONLINE LED is lit. Operating the CAP/OFF key can only be done manually by pressing the ONLINE key first to switch the HI-80 offline. However, the "SP0" command will cap the pens leaving the ONLINE LED switched on. The ONLINE switch then becomes inactive. Before any other software command can be executed or any other keys can be used, the CAP/OFF key must be pressed.

The "SP-1" command also caps the pens, but does not require the CAP/OFF switch to be pressed. Executing another command after the "SP-1" command has been given will cause the pen to return to the position it was at before the "SP-1" command was given.

ASCII Code Sequence

Decimal	(83) _D (80) _D (N) (13) _D
	or (83) _D (80) _D (N) (0) _D
Hexadecimal	<53> _H <50> _H <N> <0D> _H
	or <53> _H <50> _H <N> <0> _H

where (N) is the ASCII code for the numeric value of "n", i.e. (48)_D or <30>_H if "n" is "0", (49)_D or <31>_H if it is "1" and so on to (56)_D or <38>_H if it is "8".

VS

(Velocity Selection)

Name	Velocity Selection
Function	To specify the pen velocity.

Format	"VS _n " ▽
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Parameter type and range

"n" is a character "0" or "1". If "n" is a character other than "0" or "1" then an error is generated.

Example	LPRINT "VS1"
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When n = 0 (default value) the pen velocity is 230 mm/sec
When n = 1 the pen velocity is 100 mm/sec

If the pen is moving in a direction which is not along the axes, the speed is the resultant of the velocity in the X and Y directions. For example, the linear velocity of the pen moving at 45 degrees to both axes is $\sqrt{2}$ times the specified velocity.

ASCII Code Sequence

• For the fast speed "VS0"

Decimal	(86) _D (83) _D (48) _D (13) _D
	or (86) _D (83) _D (48) _D (0) _D
Hexadecimal	<56> _H <53> _H <30> _H <0D> _H
	or <56> _H <53> _H <30> _H <0> _H

• For the slow speed "VS1"

Decimal	(86) _D (83) _D (49) _D (13) _D
	or (86) _D (83) _D (49) _D (0) _D
Hexadecimal	<56> _H <53> _H <31> _H <0D> _H
	or <56> _H <53> _H <31> _H <0> _H

AC

(Alternate Mode)

Name	Alternate command mode
Format	"AC n" ▽
Function	Printing this string causes the plotter to change to an alternate command mode.

Parameter range

If the value of "n" is "1" the alternate plotting mode is selected. The same command is used in plotter mode 1 to switch back to plotter mode 0.

If a value of "n" less than "0" or greater than "1" is given, an error will be generated. Future options will include other plotting modes. In these cases, the error will only be generated if the option ROM is not sensed. Please consult the manual referring to that option for further details.

When changing between plotter modes, all the parameters and buffer contents are retained. However, some parameters are not the same in the two modes. Appendix F describes changing between modes.

Example LPRINT "AC 1"

ASCII Code Sequence

Decimal (65)_D (67)_D (49)_D (13)_D
or (65)_D (67)_D (49)_D (0)_D
Hexadecimal <41>_H <43>_H <31>_H (0D)>_H
or <41>_H <43>_H <31>_H <0>_H

DC2

(Text Mode)

Name	Set text mode
Format	CHR\$(18);
Function	Printing this string causes a change from plotter to text mode.

Parameter range and type

In contrast to the other commands in the plotting mode this command is simply the ASCII code (18)_D or <12>_H. This ASCII code is frequently labelled DC2 (Device Control 2). Note also that no terminator is required.

When changing to text mode, many parameters are retained, for example magnification. Appendix E describes changing between modes.

Note:

There is no command to switch to printer mode in the alternate plotter mode (mode 1). It is thus necessary to switch to plotter mode 0 and then switch to text mode.

Example LPRINT CHR\$(18);

ASCII Code Sequence

Decimal (18)_D
Hexadecimal <12>_H

4.2 Pen Positioning Commands

MA

(Move Absolute)

Name Move Absolute

Format "MAx,y" ▽

Function To lift the pen and move it to an absolute location. The pen is moved to the point with coordinate (x,y).

If a series of coordinates is given as part of the command, the pen will move from point to point without plotting.

Parameter type and range

x and y are integer numerical strings in the range -16383 to 16383 inclusive.

Examples

- (i) LPRINT "MA 1200,900"
- (ii) LPRINT "MA"; X% ; "," ; Y%
- (iii) LPRINT "MA" ; X ; "," ; Y
- (iv) LPRINT "MA" ; 1000 "," ; 200

These differ as follows:

- (i) The coordinates are printed as part of the string.
- (ii) The coordinates are printed as integer variables. The individual characters of the numbers will be sent to the printer.
- (iii) The coordinates are variables. If the variables are not integers, characters including and after the decimal point will be ignored.
- (iv) The coordinates are numerical constants, and the individual characters will be sent to the printer.

ASCII Code Sequence

Decimal

(77)_D (65)_D (X1) (X2)... (Xn) (44)_D (Y1)
(Y2)...(Ym) (13)_D
or (77)_D (65)_D (X1) (X2)... (Xn) (44)_D (Y1)
(Y2)...(Ym) (0)_D

Where (X1) ... (Xn) are the characters of the digits of the X coordinate in decimal, and (Y1) (Ym) are the digits of the Y coordinate in decimal.

Hexadecimal

<4D>_H <41>_H <X1> <X2>... <Xn>
<2C>_H <Y1> <Y2>... <Ym> <0D>_H
or <4D>_H <41>_H <X1> <X2>... <Xn>
<2C>_H <Y1> <Y2>... <Ym> <00>_H

Where <X1>... <Xn> are the characters of the decimal digits of the X coordinate, and <Y1>..... <Ym> are the decimal digits of the Y coordinate.

MR

(Move Relative)

Name

Move Relative

Format

"MR Δx , Δy "

Function

To lift the pen and move it to a location relative to the current position of the pen. The pen is moved from the current point (coordinate x, y) to the point with coordinate $(x + \Delta x, y + \Delta y)$.

If a series of coordinates is given as part of the command, the pen will move from point to point without plotting.

Parameter type and range

x and y are integer numerical strings in the range -16383 to 16383 inclusive. If the value of either coordinate of the destination point is outside the range -32768 to 32767 , an error will result.

Examples

- (i) LPRINT "MR 200,300"
- (ii) LPRINT "MR"; X% ; "," ; Y%
- (iii) LPRINT "MR" ; X ; "," ; Y
- (iv) LPRINT "MR" ; 100 "," ; 200

These differ as follows:

- (i) The coordinates are printed as part of the string.
- (ii) The coordinates are printed as integer variables. The individual characters of the numbers will be sent to the printer.
- (iii) The coordinates are variables. If the variables are not integers any characters after and including the decimal point will be ignored.
- (iv) The coordinates are numerical constants, and the individual characters will be sent to the printer.

ASCII Code Sequence

Decimal

(77)_D (82)_D (X1) (X2)... (Xn) (44)_D (Y1)
(Y2)...(Ym) (13)_D
(77)_D (82)_D (X1) (X2)... (Xn) (44)_D (Y1)
(Y2)...(Ym) (0)_D

Where (X1) ... (Xn) are the characters of the digits of the X coordinate in decimal, and (Y1) (Ym) are the digits of the Y coordinate in decimal.

Hexadecimal

<4D>_H <52>_H <X1> <X2>... <Xn>
<2C>_H <Y1> <Y2>... <Ym> <0D>_H
or <4D>_H <52>_H <X1> <X2>... <Xn>
<2C>_H <Y1> <Y2>... <Ym> <0D>_H

Where <X1>... <Xn> are the characters of the decimal digits of the X coordinate, and <Y1>..... <Ym> are the decimal digits of the Y coordinate.

HO

(Home)

Name Home position

Format "HO" ▽

Function To lift the pen and position it at the coordinate origin.

The movement to the origin is equivalent to the command "MA 0,0".

The position of the origin can be changed with the "OR" command.

If an error has occurred, on execution of this command the error is reset and the pen is moved to the origin.

Example LPRINT "HO"

ASCII Code Sequence

Decimal (72)_D (79)_D (13)_D
 or (72)_D (79)_D (0)_D
 Hexadecimal <48>_H <4F>_H <0D>_H
 or <48>_H <4F>_H <0>_H

OR

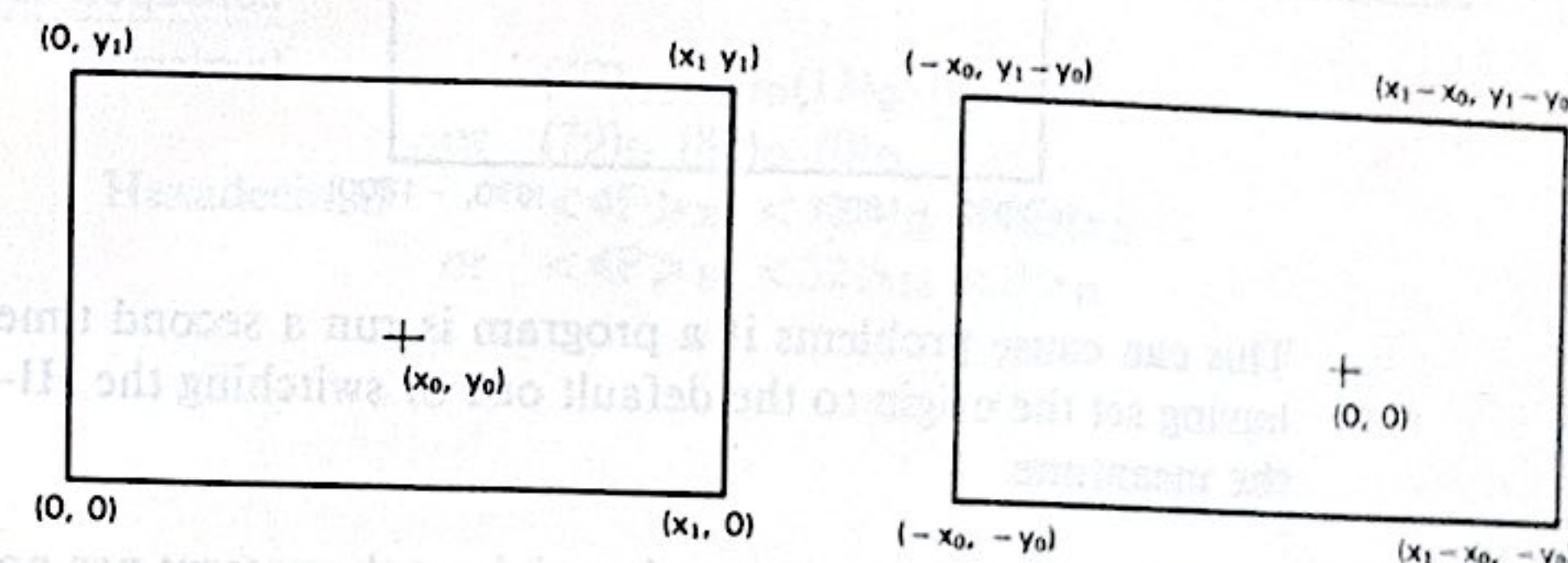
(Origin)

Name Origin

Format "OR" ▽

Function To set the pen at the current coordinate origin position.

When the origin is moved the position of the paper moves over the virtual drawing board. The size of the effective drawing area remains the same. If the pen is at a point with coordinates (x_0, y_0) and the "OR" command is given, the coordinates of the corners of the effective drawing area change as in the following diagram:



(a) Coordinates of Effective Drawing Area at Default (on power up or execution of the "DF" command)

(b) Coordinates of Effective Drawing Area after executing commands "MA x_0, y_0 " ▽ "OR" ▽

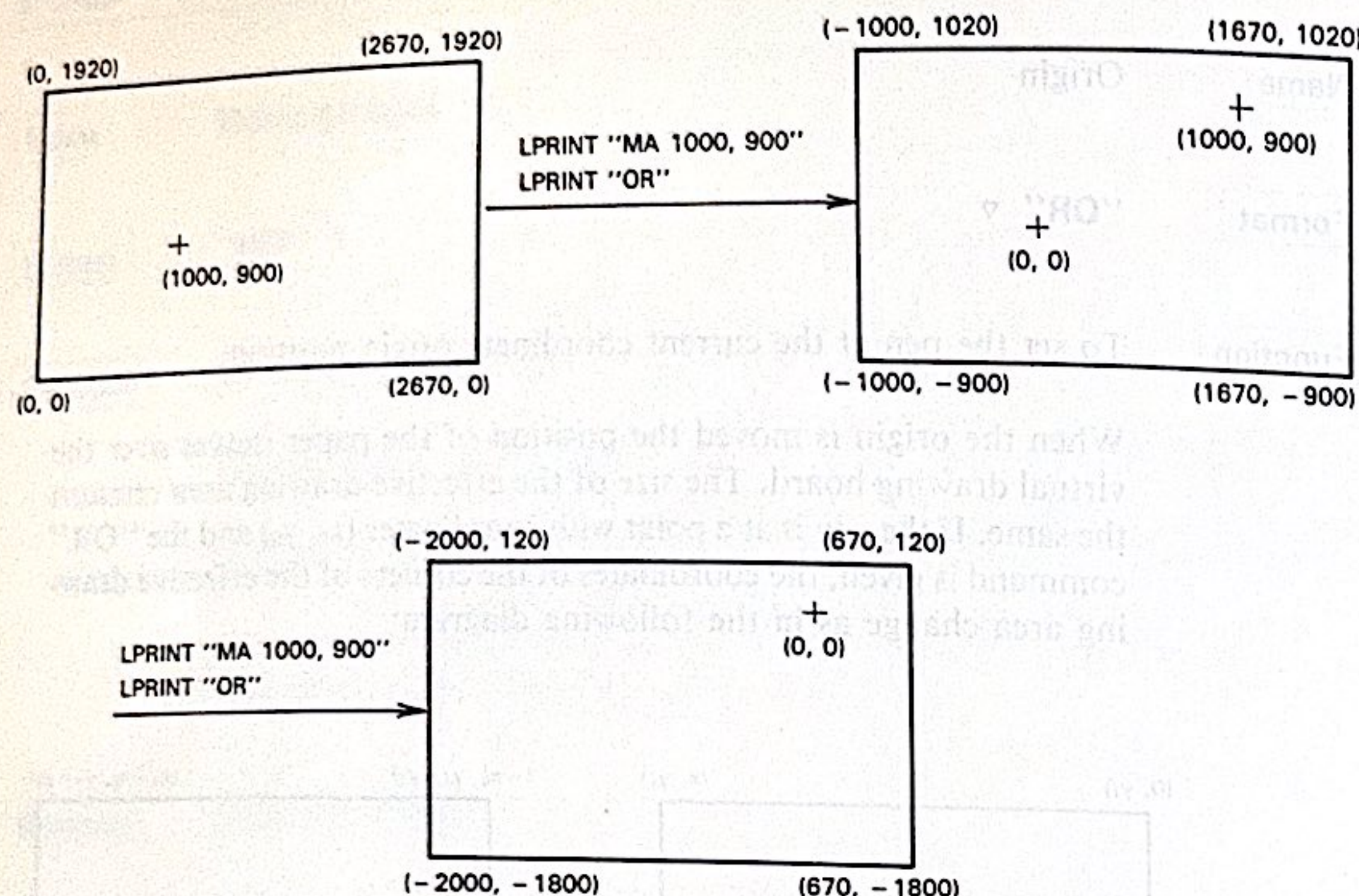
For example if the paper is set to A4, the value of x_1 is 2670, and of y_1 is 1920. If the pen is set to 1000, 900 (ie. $x_0 = 1000$ and $y_0 = 900$) then the corners of the effective drawing area become

$(-1000, 1020), (1670, 1020), (-1000, -900), (1670, -900)$

If the commands "MA 1000, 900" and then "OR" are given again without resetting the default origin, the origin moves relative to the changed origin and not to the default one. In this case the corners of the effective drawing area change to

$(-2000, 120), (670, 120), (-2000, -1800), (670, -1800)$

This is illustrated in the following diagram.



This can cause problems if a program is run a second time without having set the origin to the default one or switching the HI-80 off in the meantime.

Changing the origin only sets the origin at the present pen position on the paper. Thus if a "MA -12000, 500" command is given, the pen will move to the edge of the effective drawing area because this point is not on the paper. The position it comes to rest at will depend on the pen position before the command was issued. When the "OR" command is issued to set the new origin, it will be taken as the current pen position. The following examples will make this clear.

- (i) If a "DF" command is given the pen will go to the corner of the paper. The origin is now in the default position, as in the diagram on the preceding page. If a command "MA -200, 300" is issued, the pen will not move since this point is outside the effective drawing area. Executing the "OR" command will set the new origin, but because the pen has not moved the origin will not change.

- (ii) If this is repeated but instead of moving to the point (-200,300) directly the movement is made with the sequence "MA 0,300 , -200, 300" the origin will be a different place on the paper. The pen will be positioned at the point (0,300) on the paper although it will be positioned at (-200,300) on the virtual drawing board. This point is the same position as in the first example. Execution of the "OR" command will leave the pen 300 units along the top of the paper, a different place from that obtained in the first example, despite the pen being at the same position on the virtual drawing board.

NOTE:

This is especially important to be aware of if the input window has been altered to reduced the effective drawing area to a portion of the paper size.

ASCII Code Sequence

Decimal	(79) _D (82) _D (13) _D
	or (79) _D (82) _D (0) _D
Hexadecimal	<4F> _H <52> _H <0D> _H
	or <4F> _H <52> _H <0> _H

IW

(Input Window)

Name	Input window.
Format	"IWn" ▽ or "IW xmin,ymin, xmax, ymax" ▽
Function	To set the effective drawing area. There is a format to set this to different paper sizes, and another to restrict drawing to a particular area on the paper.

Parameter type and range

"n" is a numerical character in the range 0 to 2.

The parameters xmin, ymin, xmax and ymax are strings of numerical characters whose values must be such that the difference between them is within the following limits:

$$1 \leq (xmax - xmin) \leq 2670$$

$$1 \leq (ymax - ymin) \leq 1920$$

Example

(i) Altering effective drawing area to paper size.

If the command "IWn" is executed, the paper size can be altered under software control. If a value of "n" is given outside the range $0 \leq n \leq 2$, an error will be generated. The three values of "n" give the following results.

value of n	paper size	number of points on x axis	number of points on y axis
0	A4	2670	1920
1	US letter	2510	1920
2	B5	2270	1640

These values show the maximum number of points on each axis. The origin can be set anywhere on the paper using the "OR" command.

NOTE:

If the paper is set to A4 with the origin at the default position, and then the origin is moved to a point whose x coordinate is greater than 2270 and whose y coordinate is greater than 1640 and the paper is changed to B5 with the "IW2" command, the origin will be outside the effective drawing area. Executing a command to draw to a point having negative coordinates on both axes will result in clipping back to the edge of the effective drawing area for the B5 paper. This is the only time it is possible to set the origin outside the effective drawing area.

(ii) Altering the drawing window

If the format "IW xmin,ymin, xmax, ymax" is used, a rectangular area can be set on the paper thus limiting the effective drawing area to a desired area of the paper.

If the values of the parameters lie outside the maximum effective drawing area for the paper size, the values will be adjusted automatically to reduce the effective drawing area so that the edge of the paper becomes one or more of the borders. No error will be generated.

Repeating the command resets the window. The area will only be reduced if it overlaps the edge of the paper.

The "IF" command to magnify the values of the points has no effect on "IW" commands used in either format.

Changing the magnifying ratio with the "IF" command does not affect the effective drawing area.

Consequently if the window is to be altered after a magnification ratio has been set with the "IF" command the values used should correspond to a magnification factor of 1:1, and not to those corresponding to the magnification factor given by the "IF" command.

When the "IW" command is given the effective drawing area also defines the limits of movement of the pen which can be made using the position keys.

ASCII Code Sequences

- Format (i) "IWn" ▽

Decimal (73)_D (87)_D (N)_D (13)_D

or (73)_D (87)_D (N)_D (0)_D

Hexadecimal <49>_H <57>_H <N>_H <0D>_H

or <9>_H <57>_H <N>_H <0>_H

Where N is (48)_D or <30>_H for n = 0, (49)_D or <31>_H for n = 1 and (50)_D or <32>_H if n = 2.

- Format (ii) "IW xmin, ymin, xmax, ymax"

Decimal (73)_D (87)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (13)_D

or (73)_D (87)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (0)_D

Hexadecimal <49>_H <57>_H <x1> <x2>... <xn> <2C>_H <y1> <y2>... <yn> <2C>_H <X1> <X2>... <Xn> <2C>_H <Y2>... <Yn> <0D>_H
or <49>_H <57>_H <x1> <x2>... <xn> <2C>_H <y1> <y2>... <ym> <2C>_H <X1> <X2>... <Xn> <2C>_H <Y1> <Y2>... <Yn> <0>_H

Where (x1)...(xn) are the ASCII codes for the xmin coordinate in decimal, (y1).. for ymin, and similarly (X1), (Y1) etc correspond to xmax, ymax. In the hexadecimal notation, <x1> etc are the ASCII codes for the digits of the coordinates expressed in decimal notation.

IF

(Input Factor)

Name Input factor

Format "IF p,q" ▽

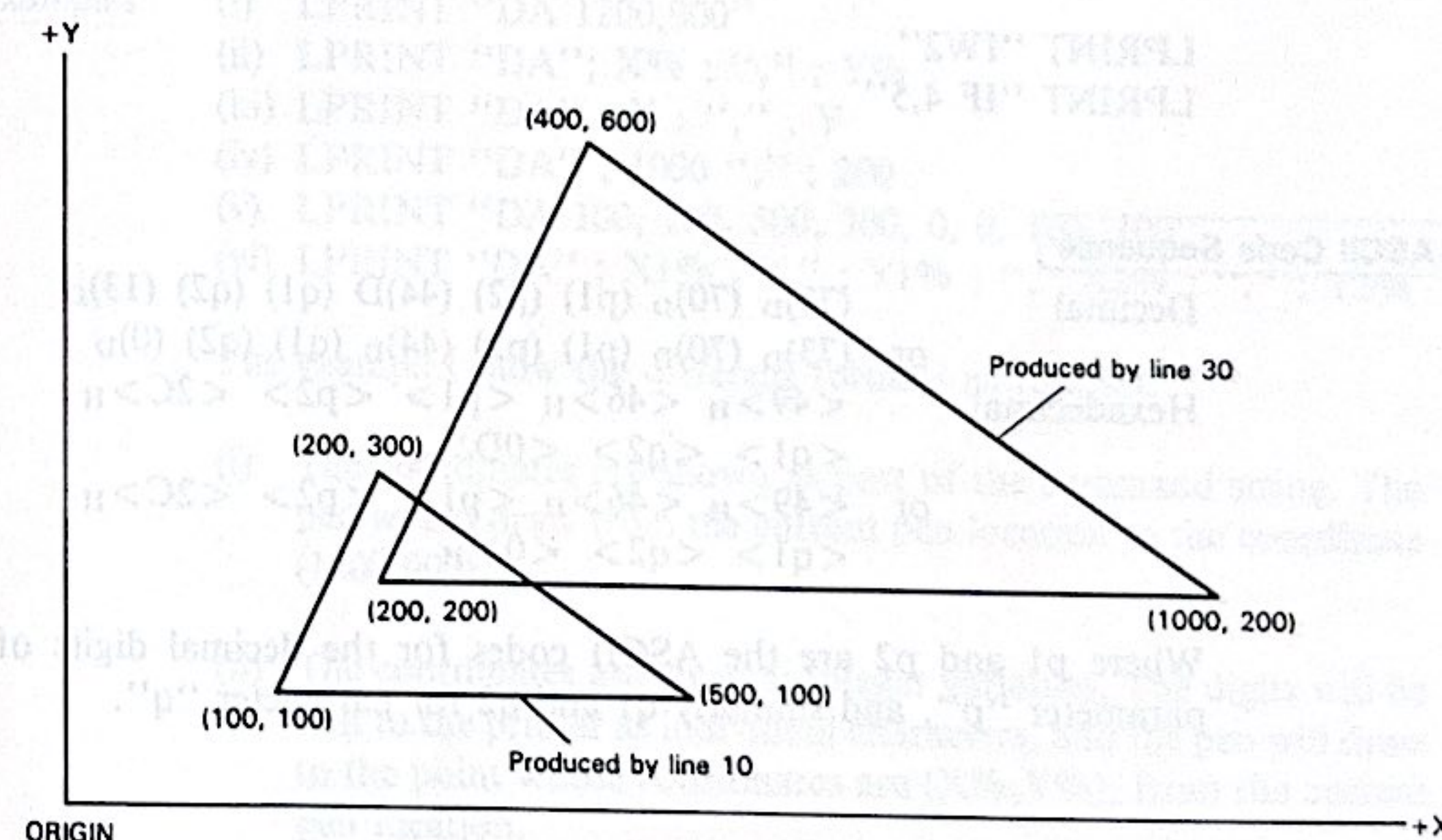
Function To set an enlargement factor.

Parameter type and range

Both p and q must be integers in the range 1 to 15 inclusive. A magnification ratio less than 1 or a non integer greater than 1 can be obtained by choosing appropriate values of p and q. For example, a ratio of 1.5 can be obtained by making p = 3 and q = 2.

Example LPRINT "IF 2,1"

This example would set the magnification factor to 2:1. It multiplies all values by 2 before plotting or moving the pen. Because it is a magnification of all values, the figure with coordinates (100,100), (200, 300), (500, 100) would be plotted at points (200,200), (400, 600), (1000,200). This is illustrated by the following program which was used to produce the figure in the diagram.




```

10 GOSUB 100
20 LPRINT "IF 2,1"
30 GOSUB 100
40 END
100 LPRINT "MA 100, 100"
110 LPRINT "DA 100, 100, 200, 300, 500, 100, 100, 100"
120 RETURN

```

Because magnification is carried out on all values relative to the origin, the "DF" or "IN" commands or an "IF1,1" command should be carried out before resetting the origin or executing any command where an absolute location is required. When a relative value command (such as "DR" or "MR") is executed, it will plot to a point whose coordinates are the sum of the current pen position plus the enlarged amount of movement specified.

All drawing commands are magnified, except those affecting the effective drawing window, i.e. using the "IW" command.

Since the effective drawing size is not affected by this command, the window should be set with the "IW" command first and then the reduction carried out using the "IF" command. For example if a drawing has been carried out on A4 paper the following commands will allow it to be carried out on B5, although slightly smaller than the correct proportion, because of the limits on the values of the parameters p and q in the "IF" command.

```

LPRINT "IW2"
LPRINT "IF 4,5"

```

ASCII Code Sequence

Decimal	(73) _D (70) _D (p1) (p2) (44) _D (q1) (q2) (13) _D
or	(73) _D (70) _D (p1) (p2) (44) _D (q1) (q2) (0) _D
Hexadecimal	<49> _H <46> _H <p1> <p2> <2C> _H
	<q1> <q2> <0D> _H
or	<49> _H <46> _H <p1> <p2> <2C> _H
	<q1> <q2> <0> _H

Where p1 and p2 are the ASCII codes for the decimal digits of parameter "p", and similarly q1 and q2 for parameter "q".

4.3 Line Drawing Commands

DA

(Draw Absolute)

Name	Draw Absolute
Format	"DA x , y" ▽ or "DA x1 , y1 , x2 , y2 , xk , yk" ▽
Function	To draw a line from the current pen position to an absolute location. The line is drawn to the location whose coordinate is (x,y). If a number of points are specified with coordinates (x1,y1), (x2,y2).... (xk,yk), the pen will draw successive lines between the points denoted by the coordinates. There is no limit to the number of points the HI-80 can receive in this command.
Parameter type and range	The coordinates x, y, xk, yk are integer numerical strings in the range -16383 to 16383.
Examples	(i) LPRINT "DA 1200,900" (ii) LPRINT "DA"; X% ; "," ; Y% (iii) LPRINT "DA" ; X ; "," ; Y (iv) LPRINT "DA" ; 1000 "," ; 200 (v) LPRINT "DA 100, 100, 500, 300, 0, 0, 100, 100" (vi) LPRINT "DA" ; X1% ; "," ; Y1% ; "," ; X2% ; "," ; Y2%

The examples show the different formats as follows:

- The coordinates are shown as part of the command string. The pen would draw from the current pen location to the coordinate (1200,900).
- The coordinates are given as integer variables. The digits will be sent to the printer as individual characters, and the pen will draw to the point whose coordinates are (X%,Y%), from the current pen location.

- (iii) The coordinates are fixed point variables. If they are not integers any characters after and including the decimal point will be ignored.
- (iv) The values are numerical constants and the individual characters will be sent to the printer.
- (v) A number of points are given inside the string, and the pen will draw from one point to the next.
- (vi) Shows the structure of a command to draw from the current pen position to two points using integer variables.

To simply draw a dot, move the pen to the position where the dot is required, and then draw a line to this same position.

ASCII code Sequence

Decimal (68)_D (65)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (13)_D
 or (68)_D (65)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (0)_D
 Hexadecimal <44>_H <41>_H <x1> <x2>... <xn> <2C>_H <y1> <y2>... <yn> <2C>_H <X1> <X2>... <Xn> <2C>_H <Y1> <Y2>... <Yn> <0D>_H
 or <44>_H <41>_H <x1> <x2>... <xn> <2C>_H <y1> <y2>... <yn> <2C>_H <x1> <x2>... <Xn> <2C>_H <Y1> <Y2>... <Yn> <0>_H

where (x1)... (xn) and (y1)... (yn) are the ASCII codes for the characters of the first coordinate in decimal, (X1)... (Xn) and (Y1)... (Yn) for a subsequent one and so on.

DR

(Draw Relative)

Name

Draw Relative

Format

"DR Δx , Δy" ▽ or
 "DR Δx1 , Δy1 , Δx2 , Δy2 , Δxk , Δyk" ▽

Function

To draw a line from the current pen position to a position whose coordinates differ by the values of (Δx, Δy).

If a number of points are specified with relative coordinates (Δx1, (Δy1), (Δx2, Δy2)... (Δxk, Δyk), the pen will draw successive lines between the points denoted by the coordinates beginning with the current pen location. Each movement will be relative to the pen position of the previous plotted point in the sequence. There is no limit to the number of points the HI-80 can receive in this command.

Parameter type and range

The coordinates Δx, Δy, Δxk, Δyk are integer numerical strings in the range -16383 to 16383.

If the absolute location of any plotted point is outside the range -32768 to 32767, an error will be generated.

Examples

- (i) LPRINT "DR 300,200"
- (ii) LPRINT "DR"; X% ; "," ; Y%
- (iii) LPRINT "DR"; X ; "," ; Y
- (iv) LPRINT "DR"; 100 "," ; 60
- (v) LPRINT "DR 100, 100, 30, 150, 65, 100"
- (vi) LPRINT "DR"; X1% ; "," ; Y1% ; "," ; X2% ; "," ; Y2%

These examples have the following results:

- (i) The coordinates are shown as part of the command string. The pen would draw from the current pen location to the coordinate (x0, y0) to the position (x0 + 300, y0 + 200).
- (ii) The coordinates are given as integer variables. The digits will be sent to the printer as individual characters, and the pen will draw to the point whose coordinates are (x0 + X%, y0 + Y%), from the current pen location with coordinates (x0, y0).

- (iii) The coordinates are fixed point variables. If they are not integers, the characters after and including the decimal point will be ignored.
- (iv) The values are numerical constants and the individual characters will be sent to the printer.
- (v) A number of points are given inside the string, and the pen will draw from one point to the next. If the pen position when the command is given is (x0, y0) the lines will be drawn from (x0, y0) to (x0 + 100, y0 + 100) to (x0 + 130, y0 + 250) to (x0 + 195, y0 + 350).
- (vi) This shows the structure of a command to draw from the current pen position to two points using integer variables.

ASCII code Sequence

Decimal

(68)_D (82)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (13)_D
 or (68)_D (82)_D (x1) (x2)... (xn) (44)_D (y1) (y2)... (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1) (Y2)... (Yn) (0)_D

Hexadecimal

<44>_H <52>_H <x1> <2x>... <xn>
 <2C> <2C>_H <y1> <y2>...
 <yn> <2C>_H <X1> <X2>... <Xn>
 <2C>_H <Y1> <Y2>... <Yn> <0D>_H
 or <44>_H <52>_H <x1> <x2>...
 <xn> <2C>_H <y1> <y2>... <yn>
 <2C>_H <X1> <X2>... <Xn> <2C>_H
 <Y1> <Y2>... <Yn> <0>_H

Where (x1)...(xn) and (y1) ... (yn) are the ASCII codes for the characters of the first coordinate in decimal, (X1)... (Xn) and (Y1) ... (Yn) for a subsequent one and so on.

LT

(Line Type)

Name

Line type.

Format

"LTp" ▽

Function

To set the type of line drawn. The line may be solid, broken, dotted or a mixture.

The spacing of the various forms of dot and dash is set with the "LP" command.

The "LT" command alters the line drawn with the following commands:

DA (Draw Absolute) VA (Curve Absolute) HP (Hatch Pie)
 DR (Draw Relative) VR (Curve Relative) AM (Absolute Mark)
 CA (Circle Absolute) GR (Grid) RM (Relative Mark)
 CR (Circle Relative) HB (Hatch Bar)

Parameter type and range

"p" is a numerical character in the range 0 to 8 inclusive. If the character "p" is "9" or any other character, an error will be generated.

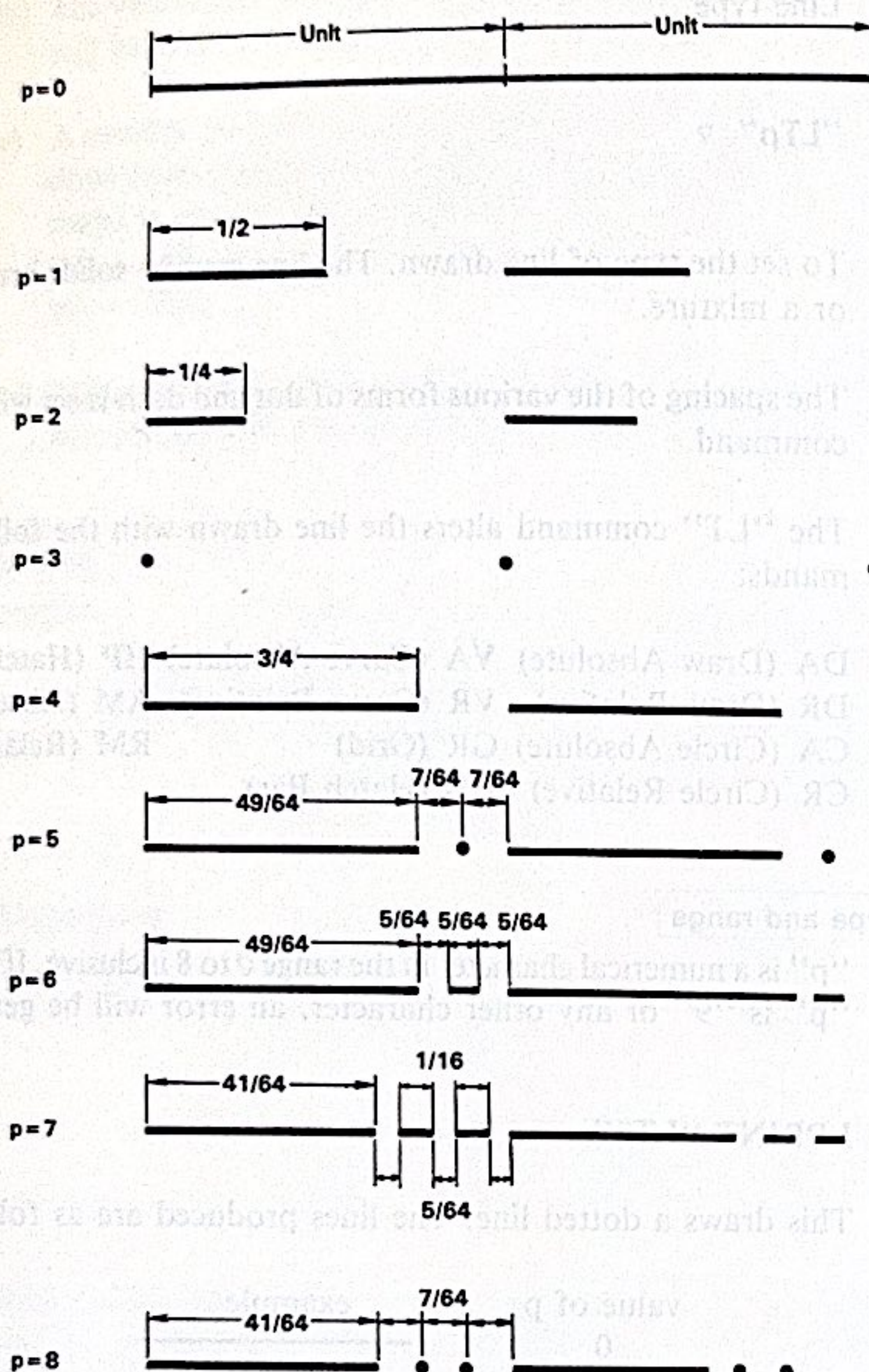
Examples

LPRINT "LT3"

This draws a dotted line. The lines produced are as follows:

value of p	example
0	_____
1	-----
2	-----
3	
4	-----
5	-----
6	-----
7	-----
8	-----

Each line is drawn in repeated units. The length of a unit is set with the "LP" command. The subdivision of each unit for the different styles is as follows:



ASCII Code Sequence

Decimal	(76) _D (84) _D (P) (13) _D or (76) _D (84) _D (P) (0) _D
Hexadecimal	<4D> _H <54> _H <P> <0D> _H or <4C> _H <54> _H <P> <0> _H

where (P) is the ASCII code for the numeric value of "p", i.e. (48)_D or <30>_H if "p" is "0", (49)_D or <31>_H if it is "1" and so on to (56)_D or <38>_H if it is "8".

LP

(Line Pitch)

Name	Line Pitch.
Format	"LPm" ▽
Function	To set the pitch of the unit specified by the line type using the "LT" command.

Parameter type and range

"m" is a numerical string in the range 1 to 16383. The value of "m" sets the length of the unit of line specified in the "LT" command. This unit length will be magnified if the "IF" command is given. However, executing an "LP" command when a magnification has been specified will treat the command as if it had been given at a magnification ratio of 1:1. The pitch will then be magnified when the line is drawn. For example:

```
LPRINT "LP80"  
LPRINT "IF 2,1"  
LPRINT "DA 500,0"
```

will produce the same result as:

```
LPRINT "IF 2,1"  
LPRINT "LP80"  
LPRINT "DA 500,0"
```

The "LP" command does not have any effect on a solid line, ie. Line Type 0.

The default value of "m" is 60 which is equivalent to a unit length of 6mm.

Example LPRINT "LP80"

ASCII Code Sequence

Decimal	(76) _D (80) _D (M1) (M2)....(Mn) (13) _D
or	(76) _D (80) _D (M1) (M2)....(Mn) (0) _D
Hexadecimal	<4C> _H <50> _H <M1> <M2>....<Mn> <0D> _H
or	<4C> _H <50> _H <M1> <M2>....<Mm> <0> _H

Where M1, M2,... Mn are the ASCII codes for the characters corresponding to the digits of the value of "m" when expressed as a decimal number.

4.4 Curve Drawing Commands

CA

(Circle Absolute)

Name Circle absolute.

Format "CA xc, yc, r, θS , θE ," ▽

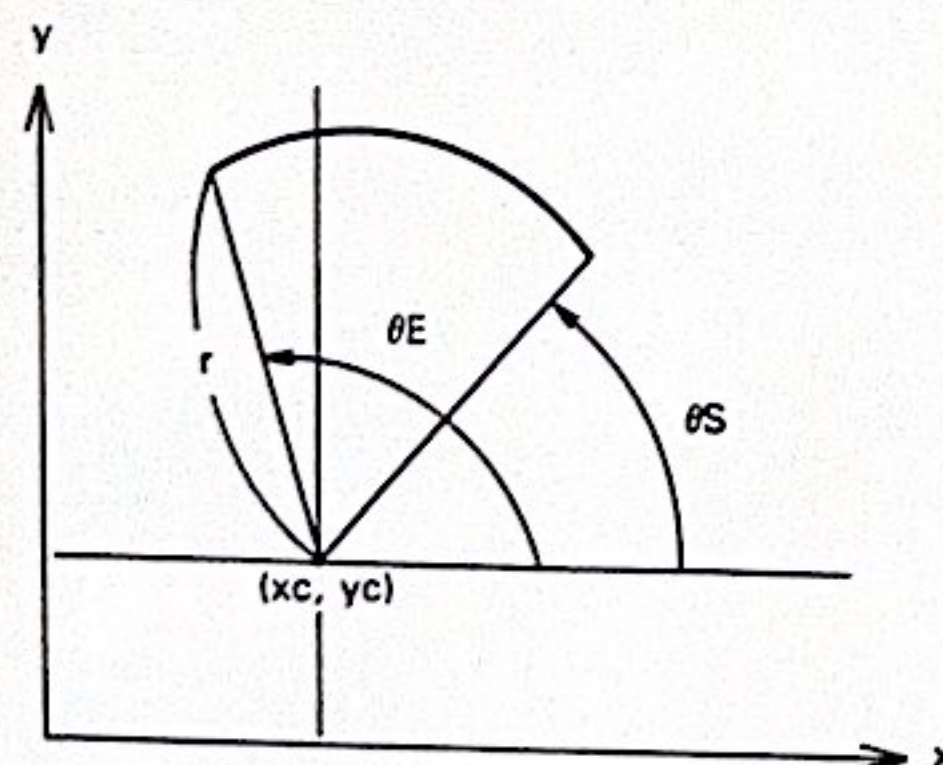
Function To draw a circle or arc of a circle with centre at absolute coordinate.

Parameter type and range

All parameters must be included. All parameters are integer numeric strings. The centre of the circle is given by the coordinates (xc,yc) and the radius by r. The starting (θS) and ending (θE) angles are given in multiples of 0.1 of a degree. The range of all these parameters (xc,yc, r, θS and θE) is -16383 to +16383.

If either of the absolute coordinates of any point of the circle falls outside the range -32768 to +32767 an error will be generated.

The angle of rotation is measured from the positive direction of the X axis such that if ($\theta S - \theta E$) is a positive angle the direction of drawing will be anticlockwise, and if it is negative the direction will be clockwise.



Examples

A more detailed explanation of defining the angle is given in section 7.1.6.

LPRINT "CA 1300,800, 200, 0, 900"

This draws a quadrant of a circle whose end radii are parallel to the X axis and to the Y axis. The centre is (1300, 800) and the radius 200. The direction in which the circle is drawn is from the X axis to the Y axis.

LPRINT "CA 1300, 800, 200, 0, 3600" draws a complete circle with centre (1300, 800) and of radius 200. The circle would be drawn in an anticlockwise direction. LPRINT "CA 1300,800,200,3600,0" would draw the same circle but the direction of drawing would be clockwise.

LPRINT "CA 1300,800,200,3600,-900" would also draw the same circle clockwise. It would continue to draw past the starting position to a point parallel to the Y axis, drawing one quadrant twice.

